

**PROFILE OF THE
HABITATS AND BIOLOGICAL COMMUNITIES
OF THE KASKASKIA PROJECT AREA
ILLINOIS**



NATURAL HISTORY SURVEY

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PROFILE OF THE HABITATS AND BIOLOGICAL
COMMUNITIES OF THE LOWER KASKASKIA RIVER

By

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SECTION 1 - INTRODUCTION

1.1 PROFILE PLAN

Many descriptions of the Kaskaskia River and its basin have been published (1,2,3,4,5,6) in which the geology, morphometry, and economics of the basin were considered. Because of these existing accounts and to stay within the scope of this profile, only physical and chemical features which directly determine or influence the biological communities will be discussed. Very little attention will be given surface and subsurface geology even though such physical features determine stream gradients which in turn strongly influence the plant and animal communities. Economic interests must be mentioned because of their direct influence on the river.

The profile developed here consists of a brief, general review of the events that have affected the river during the past century, a review of investigations that have concerned the river's water quality, aquatic habitats and their communities, an analysis of the present aquatic systems, and finally, a discussion of anticipated changes that may accompany new uses of the lower river.

1.2 CHANGES IN THE KASKASKIA BASIN

The first white man settled in the Kaskaskia Basin in 1699 and during the following years sporadic movements of immigrants arrived, some only to stay a short period of time as the control of the region changed from French to British, and to the early American colonists (4). These frontiersmen used the Kaskaskia River for transportation from the Mississippi waterway toward the interior of what is now Illinois. Kaskaskia village was formed at the mouth of the river as a center of trade and communication. The early settlers fished the river and the many floodplain pools, hunted the lowland woods, farmed along a few of the major tributaries, but in general, did not attempt to farm the main floodplain of the Kaskaskia.

The mouth of the Kaskaskia must have remained an open entrance for boats during this time, for there are records of small steamboats moving up the river for trade and transportation. On April 18, 1881, during a period of exceptionally high water, the Mississippi River broke through a neck of land in the bend of the Mississippi 2 miles above the old town of Kaskaskia, and permitted the Mississippi to flow into the lower reaches of the Kaskaskia River (3). Thus, the Mississippi appropriated the lower 7 miles of the Kaskaskia River.

This change may have caused the accumulation of sand and soft muds around the mouth of the stream, for in 1929, W. M. Luce (3), described the mouth of the Kaskaskia as being so filled with a delta

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of soft mud that water coming out of the river was distributed among numerous wide shallow channels which were difficult, if not impossible of passage, even by rowboat.

By 1880, after the Civil War, there were approximately 200,000 people in the Kaskaskia Valley (4), and it was from this time on that the economic interests of the settlers had an enormous impact on the Kaskaskia basin, the river, and its major tributaries. The Illinois Farm Drainage Act of 1879 permitted formation of drainage districts and enabled farmers to participate in the installation of drainage systems to serve large areas. Drainage proceeded rapidly during the following decades in the upper reaches of the Kaskaskia River and along several of the major tributaries, Shoal Creek, Silver Creek, and the West Okaw. Channel clearing and straightening, and ditching of poorly drained areas lowered the water table and hastened the runoff of water so that the flood peaks became higher and low flows became lower. Many aquatic habitats, marsh areas and floodplain pools that were important breeding and feeding grounds for fishes and waterfowl, were eliminated. Stream habitats were destroyed where areas were dredged and drastically modified elsewhere by changes in the water regime. During the late 1920's and early 1930's projects being considered for improving the navigation of the Kaskaskia were dropped with the conclusion that the nature of the streams is such that little if any development for navigation is possible (4). The War Department, in its statement to congress with the Rivers and Harbors Act of July 3, 1930, concluded that the development of river navigation in the basin as an additional transportational facility was not warranted by the volume of agriculture and industrial products of the region and therefore, was not receiving further consideration (1). In a comprehensive plan of development of the Kaskaskia basin (1), it is stated that "transportation of agricultural and industrial products of the region has not so far required the added facilities of a waterway and no serious consideration has therefore been given to any project to make the Kaskaskia River navigable". This same comprehensive plan (1), pointed out many possible reservoir sites, including a large upstream impoundment at Shelbyville, but did not include the mainstream impoundment at Carlyle. Soon, however, many projects for the Kaskaskia were being planned and initiated. By 1965 a dam at Carlyle was virtually complete. This dam impounded 26,000 acres of water and was planned to protect nearly 55,000 acres of land (5). By 1971 the dam at Shelbyville was impounding 11,000 acres and was supposed to provide protection for approximately 59,000 acres of land (5).

Work was begun in June 1966 to prepare the Kaskaskia River below Fayetteville for navigation. The project was virtually completed in 1973 and resulted in shortening the Kaskaskia River between its mouth and Fayetteville from 52 to 36 miles. Meanders were eliminated, much of the channel excavated, the banks piled with spoil, and the flow controlled by a lock and dam near the mouth of the river. Many drainage

projects and small impoundments are being planned for several of the Kaskaskia River tributaries. Levying and channel clearing work is planned for the mainstream in the Vandalia area and between Carlyle and Fayetteville.

These development projects outlined above have eliminated or drastically modified many aquatic habitats in the Kaskaskia Basin. Some of the influences have been immediate, others have been subtle and chronic. Whatever the influence, their impact on the existing aquatic habitats and aquatic communities must be appreciated in order to minimize the bad effects and optimize the potential for good.

1.3 THE LOWER RIVER

The approximately 100 miles of river below Carlyle Dam will be considered in this report the Lower Kaskaskia River (Fig. 1). It is the subject area of this study profile. Even though the conditions and changes upstream affect the lower river and even though many studies cited here will involve the entire basin (e.g., 6), the main attention of this report will be directed at the river below Carlyle.

The Kaskaskia below the Carlyle Dam, in its present state of development, obviously can be divided into two approximately equal segments: (A) The relatively unmodified 50 miles of stream from Carlyle Dam downstream to Fayetteville that consists of many meanders, a well-forested floodplain, riffles and deep pools, log jams, bank cover, and many floodplain pools that are annually connected with the river. (B) The drastically altered reach, formally 52 miles from Fayetteville to the mouth of the stream, where the channel has been prepared for barge traffic, the natural meanders eliminated, shallow areas deepened, vegetation removed from the bank, and the stream flow controlled by lock and dam near the lower limits. This extremely modified lower segment could be further subdivided on the basis of its degree of alteration, but such a division cannot be clearly made on what is presently known of the aquatic habitats and aquatic communities.

Although the main objective of this study profile is to evaluate the aquatic habitats and communities in the portion of the river that has been prepared for navigation, the upstream undisturbed segment is being considered to provide baselines for an evaluation of the changes that have been induced in the lower section. The upper section, with its diversity in habitats and communities, will represent the pre-construction conditions in evaluating changes that have occurred and in anticipating changes that will accompany use of the channelized river.

Some of the dimensions of the Kaskaskia River in its lower basin (Table 1), show that it is, in its lower reaches, one of Illinois' largest intra-state streams (7). The average stream widths given in Table 1 are of particular interest in that the specifications of the

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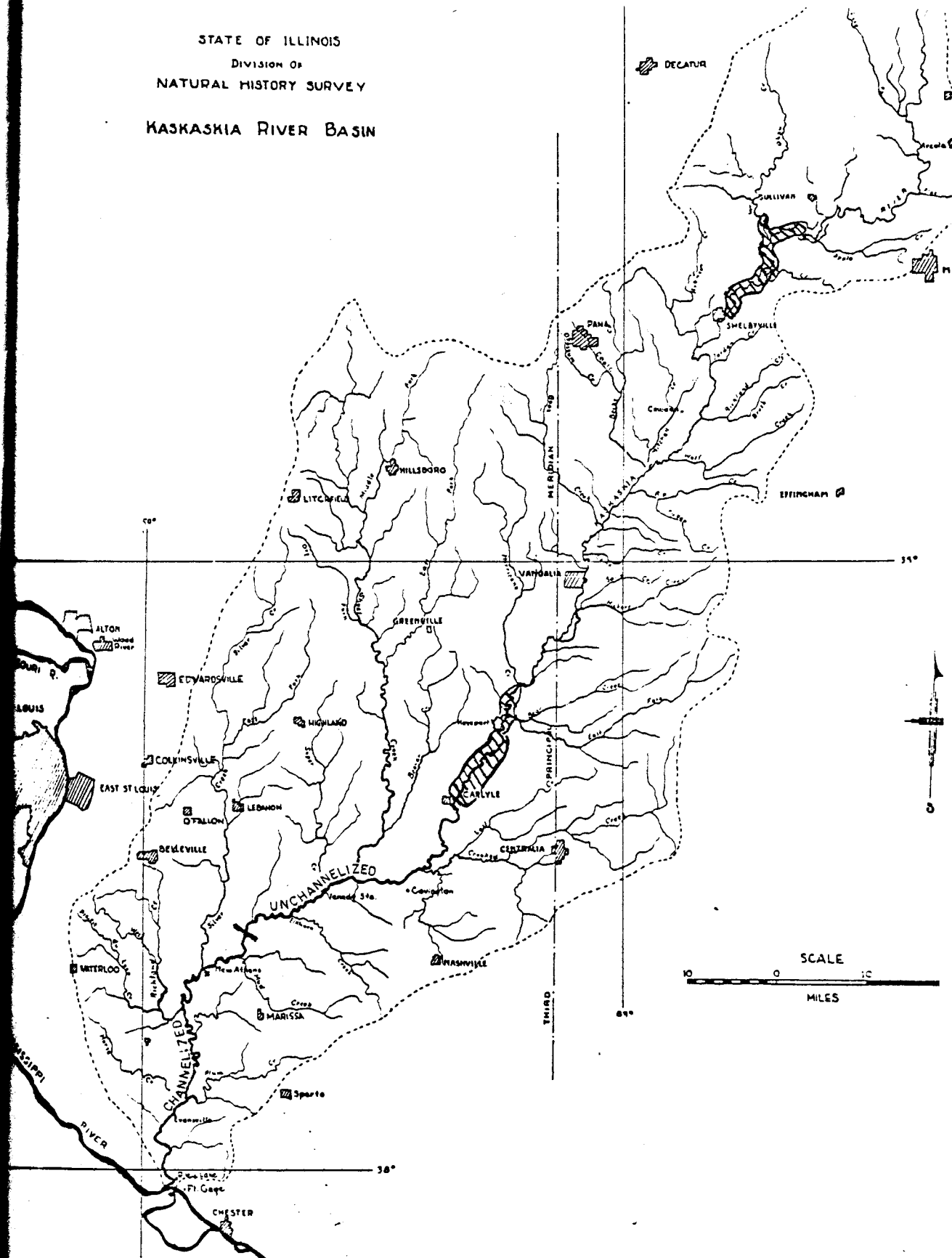


Fig. 1. Map of Kaskaskia Basin showing channelized and unchannelized areas

navigation project call for an average width of 225 ft. In St. Clair county, therefore, the stream had to be substantially widened to meet these specifications, whereas downstream in Randolph County the stream already exceeded the proposed width. Stream gradient in the channelized area of St. Clair, Monroe, and Randolph counties was, during the course of channel straightening, substantially increased by removal of large meanders, but the resulting steeper gradient loses its importance entirely under the control of the lock and dam near the river's mouth. The actual surface area of the river constitutes a substantial proportion of the surface waters in each of the counties through which it passes in the lower basin (Table 1).

Table 1. Dimensions of the Kaskaskia River in counties of the lower basin.

County	Length (miles)	Avg. Width (feet)	Surface Area (acres)	Gradient (ft/mile)	Reference*
Unchannelized River					
Clinton	16	132	254		8
(Mutual border)	25	132	398	0.20	9
Washington					
Channelized River					
St. Clair	25	165	451	0.18	11
(Mutual border)	10	200	238	0.20	10
Monroe					
Randolph	25	265	803	0.19	12

* See Literature Cited.

SECTION 2 - REVIEW OF PAST AQUATIC STUDIES

2.1 WATER QUALITY

The water quality surveillance system (Fig. 2) developed in the basin has played an important role in locating and eliminating sources of pollution during the past three decades. The U.S. Geological Survey (13), and the U.S. Army Corps of Engineers (14) have measured water stages and discharge (13); the State of Illinois Public Health Department, now called the Illinois Environmental Protection Agency, has operated an extensive water quality network (15). These compilations and other data have been analyzed for changes in quality or problems in water degradation (16, 17, 18). Surveillance programs and many special analyses (e.g. 19, 20) described specifically the chemical elements of the aquatic habitats and their related aquatic communities. Records for the lower Kaskaskia are of particular use in evaluating changes that have occurred with changes in uses of the river system.

Luce (3) considered the Kaskaskia River one of the cleaner streams of Illinois in 1929. Although he said there was little reason to believe that pollution had made any extensive inroads on the fish yield, he went on to point out that during certain periods and at certain places pollution existed to the point of destroying fish and forcing them to abandon affected regions. He described, as an example, the septic conditions that existed below Carlyle in July and August of 1930, in which untreated domestic sewage and waste from a strawboard factory and a milk plant entered the river at Carlyle to cause an oxygen deficiency downstream for a distance of 25 miles. Thousands of fish were killed.

In 1937, of the 103 incorporated municipalities in the Kaskaskia Basin, only 19 had the advantages of a public sewer system and of the 19 only 7, or 23%, of these urban populations provided proper treatment of their waste (4). A tabulation made in 1938 of pollution above and below 42 communities in the Kaskaskia Basin (1) showed that many of these communities were discharging untreated wastes into the river.

Most of the communities along the Kaskaskia River have, however, made great progress during the past two decades in the treatment of their domestic waste. For example, although black sludge from domestic waste referred to above was still being flushed into the river at Carlyle during periods of heavy rainfall in the 1960's (personal observation), this pollution has been satisfactorily eliminated. Practically no raw sewage now enters the river anywhere along its course. Most of the sewage receives both primary and secondary treatment. There is relatively little industrial pollution, although several instances of damage from industrial waste (6) have occurred in the past few years. The chief pollutants of the Kaskaskia River come from agricultural activities or from coal mining.

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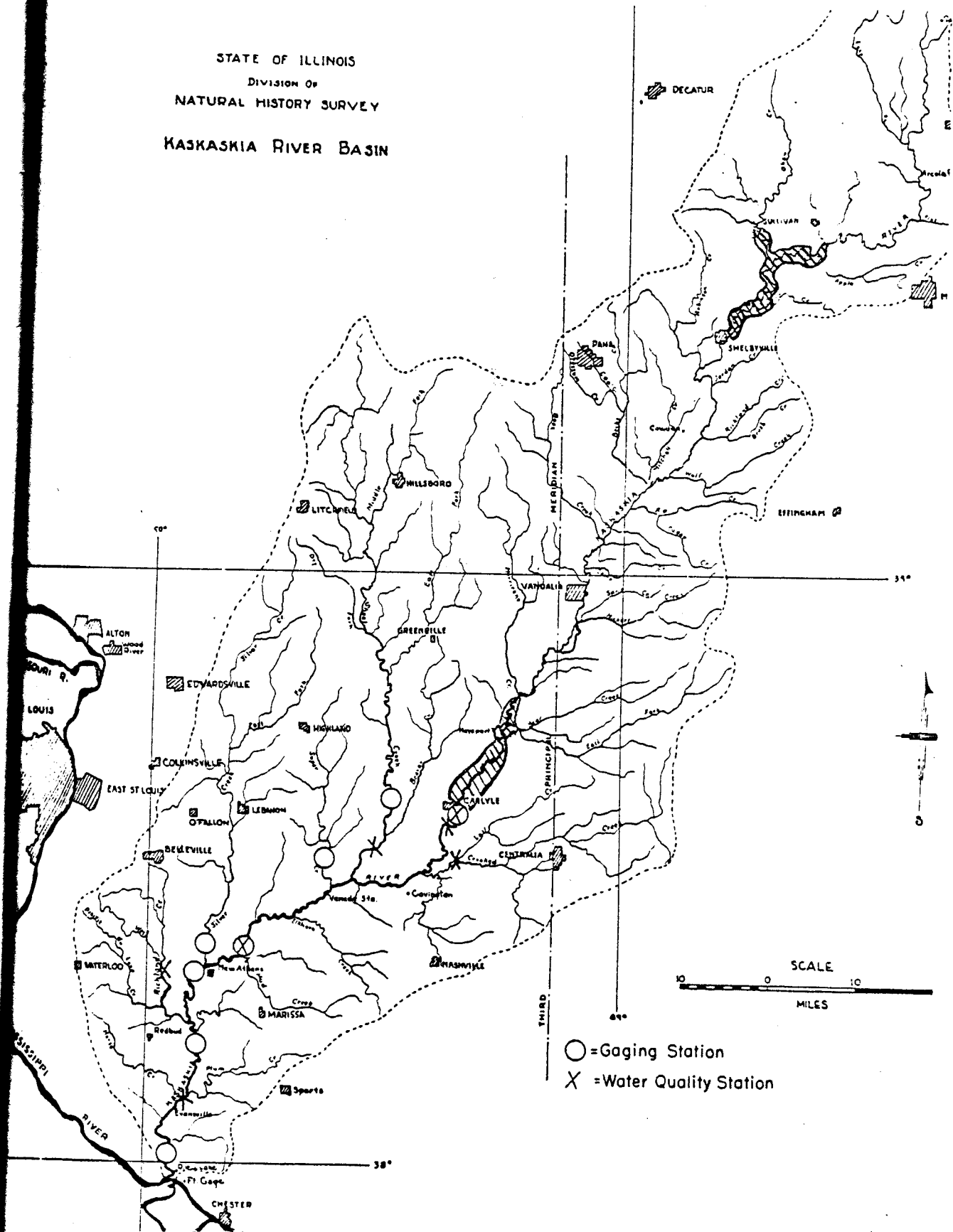


Fig. 2. Water surveillance stations in the lower Kaskaskia Basin.

The enormous increase in the use of commercial fertilizers during the past 15 years has produced a new threat to the water quality of the Kaskaskia River, especially in these areas of intensive grain farming. Harmeson, Sollo, and Larson (21) estimated that 88 per cent of the nitrates in the headwaters of the Kaskaskia River originated from soils and inorganic chemical fertilizers. In the intensely cultivated grain area of the upper basin they found increasing concentrations of nitrates during the 5 years prior to 1966 but in the lower river (New Athens) there was no significant change. Other research indicates that a substantial proportion of the nitrates in central Illinois streams may be traced directly to commercial nitrogen fertilizer (22).

Although commercial fertilizers have increased the load of nitrogen and phosphorous carried by the surface waters of the basin, there have been no instances of detrimental effects caused to the aquatic community by the increased levels of these elements as they have been carried from agricultural lands. However, these same elements, especially nitrogen as anhydrous ammonia or phosphorous as a phosphoric acid, present a major threat when they are accidentally introduced into our surface waters in concentrated dosages. Many instances of nitrogen or phosphorous spills have occurred along the Kaskaskia River and caused extensive damage to the aquatic populations. Other sources of agricultural pollution include drainage from dairy farms, especially in that portion of the basin near the St. Louis metropolitan area (4), or runoff from cattle and hog feed lots which are numerous in the upper basin. The sudden flushing of animal wastes from these operations drastically modify the stream chemistry and frequently cause fish kills and damage to other segments of the aquatic community.

Soil erosion is another source of pollution which is directly influenced by agricultural activities. Erosion, aggravated by soil cultivation, not only adds sediments to the Kaskaskia River but also adds phosphates that are absorbed to the soil particles. Throughout most of the year the Kaskaskia River carries a heavy silt load which is considered the most important form of pollution in the lower river (8, 9, 10, 11, 12). The suspended materials reduce light penetration and thereby limit the growth of submerged aquatic plants. The settled particles blanket bottom materials in quiet waters and restrict the development of benthic communities. Silt in our streams has changed the distribution of several Illinois fishes (23). Erosion of the stream bottom and bank, increased by high water levels and velocities and by boat traffic, not only adds to the materials in suspension and blankets bottom organisms on settling but also scours out bottom habitats and benthic communities. The effects of erosion and sediments are expected to be greatly increased by commercial boat and barge traffic on the lower river and will be further related to the aquatic habitats and communities discussed later in this report.

In 1937, pollution from mine wastes was considered a serious problem (24). There were 38 active and 8 inactive shipping mines and 64 load mines, most of which produced acid water in considerable quantities, sufficient, when it reached the streams, to become destructive to aquatic life. In more recent years, although coal mining has increased in the lower Kaskaskia River, the effects to control pollution from mining have been greatly intensified. Various methods have been proposed (25) for reducing pollution; stabilization of spoil deposits, deep-well and land-fill disposal of wastes, and waste treatment.

Pollution of the lower Kaskaskia River by oil field wastes oil and brine has been negligible (1). The most active oil fields are upstream of the Carlyle Dam and have no effect on the lower river. Oil pollution from barges using the lower river may be a serious source of pollution after the channel is opened for commercial traffic.

2.2 AQUATIC HABITATS

River--Before the recent preparation of the river for barge traffic up to Fayetteville, the part of the Kaskaskia referred to in this report as the lower river consisted of approximately 108 miles of meandering stream below the village of Carlyle. That section of the lower river between Carlyle and New Athens had an average width of 175 feet and bank height of 17 feet (26). Records up to 1954 showed a maximum discharge of 54,400 cfs entering this reach at Carlyle and a minimum discharge of 22 cfs. Bottom materials consisted almost entirely of silt or sand or a mixture of silt and sand with only an occasional area of small gravel. Riffles were generally poorly developed. Many meanders, however, created a wide diversity of habitats, including frequent accumulations of logs and debris, many undercut banks, and an occasional deep pool. Different habitats accommodated many species of fishes and an abundance of suitable substrates supported the development of invertebrate communities and fish food supplies.

Below New Athens and particularly below Baldwin, the river downstream to the mouth averaged 275 feet in width with banks 18 feet high (26). A maximum recorded volume of water entering this reach at New Athens was 33,000 cfs and the minimum 61 cfs as recorded up to 1954. The gradient in this area averaged 1.7 feet per mile (26). Below New Athens the bottom materials were still largely composed of silt and sand but with more frequent beds of small gravel. On downstream in the vicinity of Evansville, gravel and bedrock replaced part of the sand and silt and constituted nearly 80% of the bottom materials. The many meanders of the stream below New Athens and in the vicinity of Baldwin, created, as described in the preceding paragraph, diverse and desirable aquatic habitats. Below Baldwin the lower 20 miles of stream habitats were less diversified, with more uniform depths, even distribution of bottom materials, and steady water flows. There were fewer log jams, undercut banks, or deep pools than upstream in the meandering reaches.

Floodplain pools--Many temporary or permanent shallow pools existed in the floodplain of the lower Kaskaskia River. They were connected at some time during most years by high waters from the main river. Such pools may be formed from (6): 1. Old river meanders that are cut off as the stream changes course during geologic aging of the floodplain, 2. Depressions in the floodplain scoured out during periods of high water, 3. Depressions in the floodplain isolated by natural or artificial terrace building, and 4. Temporary or forming stream meanders (6).

In this area of the lower river where the stream gradient is low, permitting the stream to meander back and forth across a widening floodplain, there are many floodplain pools, and all of them play an important role in the aquatic system of the river basin. The importance of these waters as breeding and feeding areas for fishes and resting areas for waterfowl has been pointed out many times (6, 26).

Floodplain pools as aquatic habitats in the Kaskaskia Basin are directly influenced by the amount of shade (overhead canopy), the development of surface mats of aquatic vegetation, the amount of flushing by the river during periods of high water, and the degree of permanency, i.e., whether they dry up or exist with water throughout the year. Two of these influences, the canopy and the mat, directly inhibit penetration of light and indirectly the primary production of aquatic plants. The amount of flushing during periods of high water not only influenced the development and existence of surface mats and the deposition of silt but also the ingress or egress of aquatic organisms. The last factor listed above, whether or not they are permanent or temporary bodies of water, influences the value of floodplain pools in the total dynamics of the aquatic system. Pools that dry up may leave their entire annual production to die and dry in the dessicating basins. On the other hand, these temporary pools may be the most productive of fish foods and young fish because of the reduced, very limited competition from a permanent fish population. Permanent pools generally have a great variety of species, represented by many year classes, whereas temporary pools have relatively few species, represented by a few adults and many young. Certainly most of the floodplain pools in the basin could be considered temporary if this category includes even the smallest streamside puddles. The great value of these floodplain pools to the mainstream in the Kaskaskia River and the serious loss when they are drained to make the land suitable for other uses will be discussed in other sections of this report.

Tributaries--Three of the many tributaries that enter the lower Kaskaskia River drain one-third of the entire Kaskaskia Basin (26). Silver and Shoal Creeks flow south and enter the river from the right at miles 42 and 75 respectively, and Crooked Creek enters from the left of about mile 89. Data for these streams and for seven other tributaries

of the lower basin (Table 2) delineate the network of streams in the basin. Shoal Creek, by far the largest tributary to the Kaskaskia River, is considered one of the finest streams in the southern third of Illinois (27). Since almost all the stream banks are forested and agriculture in the floodplain has not been intensively developed, Shoal Creek is relatively free of siltation. It receives relatively little industrial or domestic pollution. Other references (8) seem to disagree with this exact description by stating that "the intensive farming operations through the watershed account for the high turbidity and siltation of the stream bed". Mention is made of oil recovery operations, and sewage treatment discharges contribute some pollutants to the stream (8). Silver Creek is one of the most important tributaries in the basin, supporting a diverse fish population and providing recreation for people in the nearby cities of East St. Louis and Belleville (11). It receives considerable amounts of serious pollution, industrial and domestic, in its upper reaches. Crooked Creek enters the Kaskaskia from the east with a low gradient (1.2 feet/mile) and bottom materials comprised mostly of silt (8). Oil-field pollution affects the midsection of the stream (28).

The upper reaches of any of the tributaries have been drastically modified by channelization and channel clearing (29). In spite of this and in spite of the drastic runoff of silt-laden water from agricultural lands, these tributaries have a great variety of habitats that support a great variety of fishes and other aquatic organisms.

Table 2. Locations and drainage areas of major tributaries of the lower Kaskaskia River (modified from ref. 26).

Name of Stream	Drainage Area (sq. mi.)	<u>Location of confluence with river</u>		
		Bank	Mile	County
Nine Mile Creek	45.0	Left	5.7	Randolph
Horse Creek	85.0	Right	12.6	Randolph
Plum Creek	91.0	Left	14.3	Randolph
Richland Creek	227.0	Right	27.7	Monroe
Silver Creek	493.0	Right	42.0	St. Clair
Mud Creek	133.0	Left	48.1	St. Clair
Elkhorn Creek	89.0	Left	62.3	Washington
Sugar Creek	179.0	Right	73.1	Washington
Shoal Creek	955.0	Right	75.2	Clinton
Crooked Creek	472.0	Left	88.9	Washington

Reservoirs--Many artificial ponds, lakes, and mainstream reservoirs have been built in the lower Kaskaskia Basin (30). They were constructed to provide water for man and livestock, flood control, and recreation. They tend to stabilize stream flow and reduce siltation in the tributaries, but otherwise play only an indirect part in the drainage system of the basin. The huge mainstream impoundment above Carlyle does, on the other hand, directly influence the entire lower river, its channel, and its immediate floodplain. Because of Carlyle Lake, water levels fluctuate somewhat less suddenly and the silt load is lowered for a few miles below the dam. Carlyle Lake adds fish-food supplies to the river below that are utilized by a large population of sport fishes.

2.3 AQUATIC COMMUNITIES

Plankton--During the summer of 1929, Luce (3) took plankton samples at each river station he visited. He reported that "plankton is of very slight importance as a source of fish food in the main stream. Practically no plankton organisms were found in the collections except in the one taken just above the mouth of the river, and even this collection contained only 11 species, none of which was very abundant". A rather intensive study of both zooplankton and phytoplankton in the upper Kaskaskia River and adjacent floodplain pools (6, 31) appears to be the only published account of plankton in this drainage system. Although conducted in the upper part of the river in Moultrie County, the general results may be applicable to the lower river. This study revealed that the river proper contained very little zooplankton but that the adjacent floodplain pools had a well-developed population composed both of crustaceans and rotifers. It appeared that the zooplankton population composition and abundance in the floodplain pools were regulated by the amount of vegetative surface cover (Lemna, Wolffia) and by predation, the predation coming both from other plankters and from associated fish populations. This intensive study (6, 31) showed that the phytoplankton followed a successional development from river to open floodplain pool to marsh pool. The total phytoplankton population increased fivefold from the Kaskaskia River to the open pool, but the species composition remained similar, predominantly diatoms, with euglenoids and green algae common. From the open pool to the marsh pool, the total phytoplankton decreased rapidly as surface mats developed and rooted vegetation became more abundant. The phytoplankton population became dominant by euglenoids able to survive under progressively more eutrophic conditions. A great abundance of microcrustacea is discharged from Lake Carlyle into the river especially at night and during the summer (32).

Periphyton--The periphyton has been rather well studied in the upper Kaskaskia River but not in the lower river. The invertebrate portion of the periphyton communities were found to colonize log substrates in the upper river, flowing the sigmoid growth curve. Initial colonization was rapid, followed by two weeks of slow growth, a rapid increase during the

next two weeks, and then leveling off at 1,650 mg per square meter during the final week (33, 34). Log substrates as sources of periphyton and fish food were found to be especially important in areas of the river with shifting sand bottoms that supported a very sparse benthic population.

In a tributary of the upper river an investigation was conducted to determine the effects of waste water treatment plant effluent on the assimilation of dissolved organic matter by the streams periphyton community (35). It was found that the periphyton assimilated two to three times more dissolved organic matter at stations influenced by the effluent than at stations not influenced by the effluent. This study showed that the attached community (the periphyton) was very sensitive to changes in the aquatic environment.

The accrual of periphyton on glass slides was followed in the upper river and several associated floodplain pools. Rate of accrual, community composition, standing crop, production rate, efficiency of production were all considered in this intensive investigation and related to various physical, chemical, and biological parameters, such as water depth, light penetration, current velocity and primary consumers (6, 31). The results of this very extensive study cannot be adequately summarized here. In general, it shows the importance of the periphyton communities in both the river, especially in areas of shifting sand, and in floodplain pools. Primary production in the river itself, where phytoplankton is sparse, is carried out by the periphyton.

Aquatic plants--Dr. Robert H. Mohlenbrock and other botanists at Southern Illinois University have studied and published extensively on the aquatic plants of southern Illinois, but no work in the Kaskaskia Basin has been conducted (personal communication). The author's general observations during the course of other aquatic work provided a summary of common vascular plants in the habitats of the lower river (Table 3).

Submerged aquatic vegetation in the Kaskaskia system is limited to smaller headwater streams (3), backwaters, and floodplain pools. Development of submerged vegetation in the main river is restricted by high turbidity, that limits light penetration, and by drastically fluctuating water levels that either drown the plants or leave them stranded on drying mudflats. Even in the floodplain pools, submerged plants may be inhibited by the high turbidity. Emergent plants and those that inhabit gravel bars, mud flats, and moist shorelines form the most diverse communities of aquatic plants. Many species could be listed. These communities change frequently because they are subjected to severe changes in water depth, degree of exposure, currents, and other physical elements.

The assemblages of floating plants that form surface mats on quiet waters (Lemna, Wolffia, etc.) cannot maintain communities in moving water

and so are restricted to backwaters and floodplain pools. Other plants with floating leaves but with roots in the substrate (eg. Nuphar) are restricted to slow-moving or quiet waters, at least in the Kaskaskia system. They provide substrates for fish-food organism, but may so completely cover the water surface as to inhibit production phytoplankton.

Table 3. Some representative aquatic vascular plants in tributaries, pools, and the main stream of the lower Kaskaskia River.

	Submerged	Emergent ¹	Floating
Tributaries	Elodea Potamogeton	Dianthera Sagittaria	
Floodplain pools and backwaters	Ceratophyllum Myriophyllum Potamogeton	Sagittaria Hibiscus Alisma Bidens Typha	Spirodella Lemna Wolffia Nuphar Jussiaea
Main River		Hibiscus Sagittaria Typha	

¹ Includes several semi-terrestrial species that grow on stream banks and bars that are often under water.

Benthos--An early survey (3) of the benthos of the river suggested that bottom animals constitute the most important source of fish food and promised that a full account of the benthos would be published later, but this account never appeared. Several studies that have been made in the upper Kaskaskia River that involved benthos (6, 32, 33, 36, 37) can not be directly related to the benthic communities that might be found in the lower Kaskaskia River. Except for a few unusual habitats, such as the rock dam below Carlyle, very few benthic organisms have been found by the author during the course of his sampling of the lower river. The sparsity of benthos is due largely to the predominance of shifting-sand and soft-silt bottom materials that do not support a permanent benthic community. The occurrence of an abundance of benthic organisms in drift collections (32), to be discussed later, revealed special habitats supported benthic communities along the lower river. Such special habitats would include stable mud banks, backwater areas, submerged substrates, such as logs, and an occasional area of gravel or small rubble. Since sand-silt bottoms contain few organisms and since the special habitats just mentioned are difficult to investigate, more has been learned about benthic communities by examining drift collections than from sampling the actual bottom

materials. Organisms that have been found to comprise the sparse benthos generally include midge larvae (Chironomidae), mayfly nymphs (Ephemeroptera of several genera), worms (Oligochaeta, Nematoda), and an occasional freshwater mussel. Drift collections show that caddisfly larvae (Trichoptera) should be added as an occasional component of the benthos.

Five collections of mussels were made on the Kaskaskia River in 1929, and two of these collections, from Carlyle and Vennedy Station, made an interesting comparison with later collections (3). Fourteen species of mussels were found at Carlyle and four species at Vennedy Station, making 16 species altogether from this part of the lower river. The smaller number taken at Vennedy Station is not explained.

Collections taken during the 1960's included 17 species from this area (unpublished data), and 8 species from the Evansville area. The key to the freshwater mussels of Illinois (38) is useful in identifying the mussels of the Kaskaskia River but includes relatively few records for this drainage. Statistics for 1922 (3), show that the mussel shells, pearls, and slugs coming from the Kaskaskia River during that year were valued at \$2,880. It is doubtful that the commercial value ever exceeded this amount; there appeared to be a decline in mussel fishing from that time on. A recent summary of freshwater shell industry (39) includes no account for the Kaskaskia Basin.

Sedimentation and shifting sand may be factors limiting the mussels in the Kaskaskia River, but less directly involved would be the paucity of plankton, as food for the mussels, supported by the turbid stream.

Drift organisms--Stream drift is composed of those benthic organisms that, for some reason and at certain times (mostly at low-light intensities), leave the bottom materials or submerged substrate to float with the moving water mass of the river. As mentioned in the preceding paragraph, much can be learned about benthic organisms by studying collections of stream drift, especially in those areas such as the lower Kaskaskia River where bottom materials seem to contain a paucity of organisms. Several studies of stream drift have been made in the upper part of the Kaskaskia River (6, 36, 37, 32). Only one of these (32) has collected information on drift in the lower river. This study revealed that soon after sunset (a period of normally peak drift) there was a total of approximately 10 milligrams of drift organisms per cubic meter of water passing down the stream near, and below, Carlyle before the reservoir (Carlyle Lake) was formed. This weight of organisms was distributed among microcrustacea, mayfly nymphs, caddisfly larvae, diptera larvae and pupae, and a few other aquatic insects. Impoundment of the river at Carlyle had a drastic influence on the composition of the drift immediately below the dam but did not drastically change composition of the drift 5 miles downstream. The composition of the drift in the main river is also influenced by flushing of organisms from floodplain pools

during periods of high water. Most of the organisms found in drift collections are choice fish food items, and because of their vulnerability, comprise an important part of food of river fishes.

Fishes--Early listing of the fishes of Illinois (40, 41, 42) indicated that no collections had been taken from the Kaskaskia Basin before the turn of the century. Even the extensive collecting of Forbes and Richardson in the early 1900's (2) included only a collection in the vicinity of Carlyle and none farther downstream in the lower river. "A Survey of the Fisheries of the Kaskaskia River" (3) was the first published account of the fishes of the lower river. This survey included not only the distribution of most of the species known to occur there but also notes on their habitat requirements and value to the fisheries. An account published in 1935 summarizes these earlier surveys of Illinois fishes and added some additional records (44). It gave relatively little new information on the Kaskaskia River.

A considerable amount of new information was gathered by biologists of the Illinois Department of Conservation in their surveys of county surface water resources (7, 8, 9, 10, 11, 12). Although these surveys included very little collecting in the main river, they did improve the information on fish distribution in the lower basin, especially in some of the major tributaries. A recent annotated list of the fishes of Illinois (45) brings up to date the names and known distribution of fishes in the Kaskaskia River. In recent years several studies of special groups of fish have been published, such as investigation of four darters (46) and the madtoms (47).

The published accounts mentioned above, and the unpublished information collected by the author during the past two decades, indicate that 78 species of fishes have been collected from the lower Kaskaskia basin. Of these species, the largemouth bass, white crappie, black crappie, carp, and channel catfish can be considered the most important sport fishes. Other important species in the anglers catch include bowfin, yellow and black bullheads, flathead cat, several species of sunfish, and the freshwater drum. Bank poles and trotlines baited with natural baits (worms, minnows, crayfish, liver, etc.) are commonly used. Fishing with artificial lures is mostly restricted to floodplain pools because of the high turbidity of the main river.

A report (26) published in 1954 gave substantial amount of detailed information on the recreational value of the sport fishery; a value of \$11,000 was established for the fishery between Carlyle and New Athens. A later report (48) gave the number of anglers using the Kaskaskia Basin in 1960 and projections of usage for 1980, 2000, and 2020. Although not showing what proportion of the fishing was in the lower basin, these figures indicated a tremendous increase in fishing pressures each period.

The lower river has also had a significant value as a commercial fishing area. Statistics for 1922 (49) gave a value of the fish, turtles and frogs from the Kaskaskia River as \$3,720. This figure included only the commercial fishing in the lower river because the year before the Kaskaskia and its tributaries from Carlyle to Covington Bridge was made a fish preserve. Catfish and bullheads made up one-third of the value of this catch from the lower river in 1922. Buffalo, carp, and drum also were important. In 1965, there were no full-time and only 14 part-time commercial fishermen employed in the Kaskaskia Basin (48). In 1973, there were only nine or ten licensed commercial fishermen active in the lower basin. They fished irregularly, mainly during periods of best production, and did not depend on fishing for their livelihood. One fisherman did not have another occupation but certainly was not a full-time operator.

Accumulated fishing statistics (such as 50, 51) gathered over the years show that regulations, creating fish preserves on the Kaskaskia River, have played an important role in determining the fluctuating commercial importance of fishing in the lower river.

Water Birds--Many birds are directly associated with the water areas of the lower Kaskaskia Basin. Few are year-around residents; most of the species are transients or seasonal residents, so that the bird communities change drastically with the seasons. Some species, such as the prothonotary warbler, roughwing swallow, etc. prefer to feed and nest around aquatic habitats, but otherwise cannot be considered water birds. The shore birds, such as spotted sandpiper, greater yellowlegs, water-thrush, wade and feed along the shoreline and are more directly associated with the river and standing water areas. Several species of herons, the great blue, green, night herons, nest next to or over the waters of the Kaskaskia and feed directly on aquatic organisms. A vast assemblage of ducks, coots, and rails that move through the Kaskaskia Valley in their migrations use the water areas for different lengths of time in different seasons of the year. Especially large concentrations of ducks stop on the backwater areas and floodplain pools of the lower Kaskaskia River during their fall migrations. These waterfowl concentrations attract many hunters as can be shown by the clustering of cabins and hunting clubs in the lower basin. There are especially attractive water fowl areas in Randolph County (12), St. Sinclair County (11), and Monroe County (10), and along the tributaries and some of their backwaters (27).

The marshes and streams of the lower portion of the Kaskaskia Basin form ideal shelters for water birds (1). Many of these valuable habitats have been damaged or entirely eliminated by dredging and channelization (4,26).

SECTION 3 - PRESENT AQUATIC HABITATS AND THEIR COMMUNITIES

3.1 NATURAL CHANNELS

The channel of the Kaskaskia River from Carlyle to Fayetteville still remains in a fairly undisturbed state. Only minor work has been done in the actual river. This area is, of course, affected by modifications of the flow by the upstream impoundment at Carlyle and by agricultural practices in the floodplain. This reach to the river otherwise represents the only part of the lower Kaskaskia River that still has its natural stream gradient, its normal distribution of riffles and deep pools, its frequent meanders, and a natural water regime that calls for flooding of adjacent floodplain at intervals during the year. As described in the previous section, these physical characteristics produce a diversified habitat that supports a diversified aquatic community. All the species of fishes known to the lower Kaskaskia River can be found in the area between Carlyle and Fayetteville, in contrast to a fish community with many missing species in the similar length of stream from Fayetteville to the river's mouth that has been modified. The natural channel not only provides habitat for the many kinds of fishes, it provides areas for their reproduction, for the production of food supplies, and for shelter during different seasons of the year.

Construction of the proposed levees along the banks of this natural channel (26) would drastically change this valuable and interesting part of the Kaskaskia River. It is valuable not only to the people who enjoy fishing, hunting, and the natural communities, but also as an area that absorbs floodwaters to be temporarily stored and naturally released to augment later periods of low flow.

3.2 MODIFIED CHANNEL

Practically any channel modification reduces the diversity of the aquatic habitats and the value of these habitats for supporting aquatic communities (52). The Kaskaskia River below Fayetteville, while not in an entirely new channel, has been so modified that the aquatic habitats and their communities have been drastically changed. All of the members have been removed to prepare the course for barge traffic. All of the shallow areas have been deepened, and many of the banks have been disturbed by dredging or by the deposition of spoil. No log jams or undercut banks remain to provide shelter for aquatic communities. Many fishes and aquatic invertebrates that formerly inhabited these reaches now find them unacceptable.

In spite of the loss of many aquatic forms, the modified channel could support a moderately productive aquatic community, providing there is stability of the bottom materials and banks and not an excessive rate

of sedimentation, conditions which will be discussed later in this profile. Several species of minnows, suckers, young catfish, mayflies, and midges would use the modified channel except for these disturbances mentioned above.

3.3 NEW CHANNELS

Much of the lower Kaskaskia River below Fayetteville has been moved into a newly dug channel. Such new channels, of course, are straight with uniform current and depth and with no obstacles to the flow. The invasion of aquatic organisms is rapid and the population will gradually become established if suitable habitats are available. The actual production of the aquatic communities tends to increase as such newly created water areas accumulate organic materials to support the growing plants and animals. The source of the invading animals is mainly through downstream drift of stream invertebrates and the normal movements of fishes.

The undesirable uniformity of a new channel means there are fewer different habitats and thus fewer kinds of organisms than might be expected in a natural river. The absence of shelter (log jams, undercut banks, deep pools) and the instability of both the bottom materials and the banks make these habitats and their communities especially vulnerable to changes such as accompany floods and droughts. High water velocities can easily displace aquatic organisms in such vulnerable situations and the lack of deep pools eliminates a refuge for the organisms during dry periods.

Many investigations have shown that very few benthic organisms can tolerate shifting bottom materials and that usually sand bottoms are the areas of least production in any stream. In a new channel, with its predominance of sand in the bottom materials, one can expect very little benthic populations, possibly composed of a few kinds of mayflies and annelid worms. Freshwater mussels may be present in low numbers. A few species of fish, occasionally present in large numbers, may use the new channels as temporary feeding areas. Several minnows (sand shiner, red shiner), suckers (young of several species, carpsuckers), and young channel catfish may be found in straight, open channels, often in large numbers.

3.4 ARTIFICIAL CUTOFFS

As the river channel was modified below Fayetteville, many natural meanders were left to the side of the straight channel. These cutoff reaches of the stream were separated from the river at the upper end but left open and connected to the river at the lower end. Thus was created a water area somewhat comparable to naturally formed backwaters and oxbows.

These artificial cutoffs, purposely left open at the lower end to permit movements of aquatic organisms in and out of the areas, are ordinarily highly productive. Although there is little information on the dynamics or management needs of these artificially created water areas, one can anticipate their use as feeding grounds for many fishes along the lower Kaskaskia River. Also, they would be the major source of both phytoplankton and zooplankton, and benthic organisms which may be scarce in the main channel. Gizzard shad, buffalo carp, and such desirable sport fish as crappie and largemouth bass may be found to use these cutoff channels throughout much of the year and may well find them valuable refuges during periods of flooding. Large populations of several kinds of mayflies, midges, phantom midges, and sludge worms may be expected to develop in these areas.

As information accumulates on these artificial cutoffs, management procedures should become obvious. It may become necessary to partially open the upper ends of the artificial cutoff in order to reduce stagnation of the water and to eliminate sediments that accumulate at the lower ends of the channel.

3.5 FLOODPLAIN POOLS

Although many floodplain pools have been eliminated by drainage and many others below Fayetteville eliminated by alteration of the river's course, valuable floodplain pools still exist along the river between Carlyle and Fayetteville. As discussed in a previous section of this profile, floodplain pools are extremely important aquatic areas unto themselves and play an important role in the dynamics of the main river and its tributaries (6, 23).

Floodplain pools that have not been destroyed by dredging or channelization still contain the same aquatic communities as found earlier and described previously in this paper.

3.6 TRIBUTARY STREAMS

Streams draining into the lower Kaskaskia River presently contain a great variety of fishes and may in some areas be more healthy aquatic habitat than a few years earlier before an effective program of pollution abatement was initiated. The streams that join the Kaskaskia in the channelized area below Fayetteville may have their lower reaches changed by inundation with backwaters from the channel and by deposition of sediments as a result of these backwaters. If operation of the lock at the mouth of the main river inhibits the upstream movements of Mississippi River fishes, a change in some species may be noted even in the tributaries. With the modification of the main river and the destruction of most of its natural habitat, the tributaries may assume a new importance as areas of fish production and refuge in the lower basin.

3.7 IMPOUNDMENTS

Farm ponds, village water supply reservoirs, and other small artificial impoundments are scattered throughout the lower Kaskaskia Basin. These impoundments tend to stabilize stream discharge, and in many instances contribute fishes such as largemouth bass and bluegills to the tributaries and main river. The only artificial impoundment with a major impact on the lower river is Carlyle Lake, the 26,000-acre impoundment through which flows most of the water of the lower Kaskaskia River. This huge reservoir cannot be considered an aquatic habitat of the lower river since it is above limits of this review, but it does indeed have a strong influence on the downstream portion of the river.

SECTION 4 - ANTICIPATED CHANGES

4.1 FAVORABLE CHANGES

Stabilization of water levels below Fayetteville, where the river waters are influenced by the lock and dam near the mouth. Although many stream organisms benefit from fluctuations in water level, maintaining a minimum level in the channelized area will eliminate some of the stresses created by extremely low flows caused by extended drought.

Additional cutoff lakes created from old meanders as the river was straightened. These water areas will be valuable feeding and breeding grounds for many fishes.

4.2 UNFAVORABLE CHANGES

Reduction in stream length. Sixteen miles of the river were eliminated when the channel downstream from Fayetteville was reduced for 52 to 36 miles in length.

Reduction in stream habitats. Many major habitats (deep pools, gravel bars, etc.) were entirely eliminated by channelization. Many more less obvious microhabitats were destroyed, leaving an unknown number of aquatic organisms without their specific ecological requirements for shelter, feeding, and breeding.

Reduction in primary production. Although nowhere in the main channel of the Kaskaskia River does there exist a large phytoplankton community, attached algal communities (periphyton) are, on the other hand, very productive, and contribute to the food base of all the aquatic animals. Elimination of suitable substrates (logs, etc.) and the reduction in light penetration caused by higher levels of inorganic materials kept in suspension by barge turbulence may greatly reduce primary production in the main channel.

Increased sedimentation of main channel. The upper part of the channelized river below Fayetteville can be expected to receive and accumulate more sediments than before channelization. As the sediment-bearing river water enters this canal and the water velocity decreases, some of the suspended silts and clays will be dropped. This deposit of sediments may drastically reduce benthic production.

Instability of bottom materials. Not only will bottom materials be altered by erosion and sedimentation, they will be disturbed by propeller wake and pressure waves of the passing barges. Fine silts may be brought back with suspension and increase water turbidity.

Filling of cutoff lakes and floodplain pools. Stabilization of water levels by the lock and dam will reduce the flushing of some of the natural floodplain pools and artificial cutoffs along the channelized river. Increased sedimentation and stagnation will result, drastically reducing production of these waters and eventually lead to their filling with accumulated silts.

Sedimentation of tributary mouths. Water velocities will be reduced in the lower reaches of some of the tributaries because of water levels maintained in the barge canal. The reduced currents will cause sediments to be deposited and accumulate in the mouths of these streams.

Fish movements blocked by lock and dam. Although it is known that some river fishes move through locks with the passing of boats, the movements of other species may be inhibited, and at certain water levels or seasons of the year a lock and dam may be a serious barrier. Since a substantial portion of the commercial harvest of fish from the lower Kaskaskia Basin are of fish that have temporarily moved up from the Mississippi River, these movements may be reduced.

Acceleration of bank erosion. Disturbance of the river banks during channelization, lack of vegetative cover, and extreme washing by waves from the commercial barges, all contribute to bank erosion. Erosion will be a continuously serious problem both because of bank destruction and because materials sluffed from the banks will fill the canal.

New sources of pollution. Barge oils, mine waters, coal spoils, new industries, and new communities are among the many threats of pollution that will exist with the commercial use of the lower river.

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